



**EAST WATERWAY OPERABLE UNIT
SUPPLEMENTAL REMEDIAL INVESTIGATION/
FEASIBILITY STUDY
FINAL SURFACE WATER DATA REPORT**

For submittal to:

The US Environmental Protection Agency
Region 10
Seattle, WA

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Acronyms

ACRONYM	Definition
ACG	analytical concentration goal
ARI	Analytical Resources, Inc.
AWQC	ambient water quality criteria
BEHP	bis(2-ethylhexyl) phthalate
CCV	continuing calibration verification
CFR	Code of Federal Regulations
COC	chain of custody
cPAH	carcinogenic polycyclic aromatic hydrocarbon
CVAC	cold vapor atomic fluorescence
EPA	US Environmental Protection Agency
EW	East Waterway
FS	feasibility study
GC/MS	gas chromatography/mass spectrometry
HPAH	high-molecular-weight polycyclic aromatic hydrocarbon
HRGC/HRMS	high-resolution gas chromatography/high-resolution mass spectrometry
ICP-MS	inductively coupled plasma-mass spectrometry
ID	identification
J-qualified	estimated concentration
LCS	laboratory control sample
LCSD	laboratory control sample duplicate
LPAH	low-molecular-weight polycyclic aromatic hydrocarbon
MDL	method detection limit
MS	matrix spike
MSD	matrix spike duplicate
NOAA	National Oceanic and Atmospheric Administration
NTU	nephelometric turbidity unit
PAH	polycyclic aromatic hydrocarbon
PCB	polychlorinated biphenyl
ppt	parts per thousand
QA	quality assurance
QAPP	quality assurance project plan
QC	quality control
RL	reporting limit
SDG	sample delivery group
SIM	selective ion monitoring
SRI	supplemental remedial investigation

ACRONYM	Definition
SVOC	semivolatile organic compound
TEQ	toxic equivalent
TOC	total organic carbon
U-qualified	not detected at a given concentration
WAC	Washington Administrative Code
Windward	Windward Environmental LLC
WQC	water quality criteria

1 Introduction

This data report presents the surface water chemistry data collected from the East Waterway (EW) during five sampling events from September 2008 to February 2009 as part of the EW supplemental remedial investigation/feasibility study (SRI/FS). These surface water sampling events were conducted to collect seasonal surface water data in the EW according to methods and sampling design presented in the quality assurance project plan (QAPP) (Windward 2008). The first two sampling events occurred in the dry season on September 11 and 12, 2008 (Round 1), and from September 25 to 27, 2008 (Round 2). The sampling events conducted during wet-weather conditions were from December 9 to 11, 2008 (Round 3), and February 21 to 23, 2009 (Round 5). An additional event was conducted from January 7 to 9, 2009 (Round 4), to capture conditions following a storm event.

Data collected in this study will be used in evaluating risk to humans and fish and wildlife from surface water exposure in the EW human health and ecological risk assessments. These data may also be used to support the development of a food web model and to evaluate sediment transport and associated recontamination potential.

This report is organized into sections that address field and laboratory methods, chemical analytical results, and references. The text is supported by the following appendices:

- ◆ Appendix A – Data Tables
- ◆ Appendix B – Data Management
- ◆ Appendix C – Data Validation Reports
- ◆ Appendix D – Laboratory Report Forms
- ◆ Appendix E – Collection Forms and Field Notes
- ◆ Appendix F – Chain-of-Custody (COC) Forms

2 Field Collection and Sample Processing Methods

This section describes the collection of surface water samples, as well as sample processing methods. The field procedures are described in greater detail in the QAPP (Windward 2008). Field deviations from the QAPP are also presented. Copies of field forms, notebooks, and laboratory forms are presented in Appendix E, and completed COC forms used to track sample custody are presented in Appendix F.

2.1 SAMPLE COLLECTION AND PROCESSING

Surface water samples were collected during five events as listed in Table 2-1. Sampling was conducted at four locations during Round 1 (EW-SW-1 through EW-

SW-4) (Map 2-1). After Round 1, location EW-SW-4 was replaced by two additional locations, EW-SW-05 and EW-SW-06, per US Environmental Protection Agency (EPA) direction. Sampling was conducted during an ebb tide (i.e., outgoing), during the 3 hrs before low tide, except at location EW-SW-03 in Slip 27, which was sampled during the slack tide. During Round 4, samples were also collected during a flood tide (i.e., incoming) at the three locations in the main channel (EW-SW-01, EW-SW-02, and EW-SW-06).

Table 2-1. Locations and tidal stages for surface water sampling

Sample ID	Sampling Location					
	EW-SW-1	EW-SW-2	EW-SW-3	EW-SW-4	EW-SW-5	EW-SW-6
September 11 – 12, 2008 ^a	E	E	S	E	ns	ns
September 25 – 27, 2008 ^a	E	E	S	ns	E	E
December 9 – 11, 2008 ^b	E	E	S	ns	E	E
January 7 – 9, 2009 ^c	E/F	E/F	S	ns	E	E/F
February 21 – 23, 2009 ^b	E	E	S	ns	E	E

^a Dry season sampling event

^b Wet season sampling event

^c Storm sampling event

E – sampled during ebb tide

F – sampled during flood tide

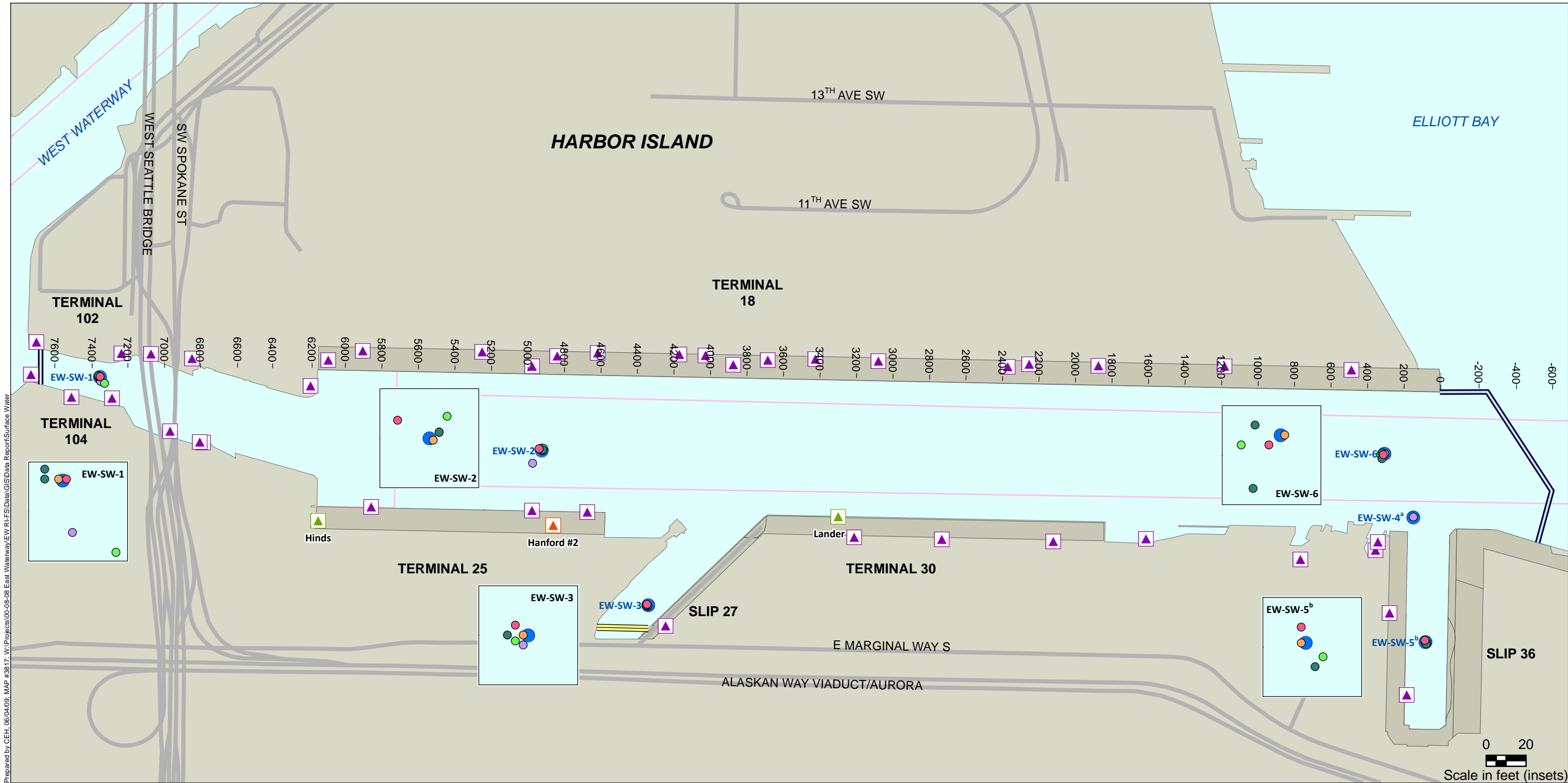
ID – identification

ns – not sampled

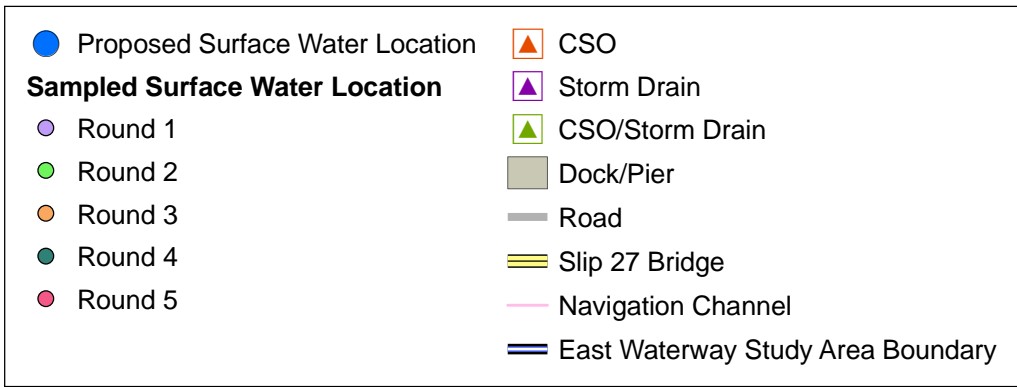
S – sampled during slack tide

Sampling methods are presented in detail in the QAPP. Samples were collected by pumping water to the surface using a peristaltic pump and decanting directly into sample containers. Each location was sampled at two depths within the water column, 1 m below the surface and 1 m above the bottom. Trace metals and mercury sample containers were filled first following EPA Method 1669 “clean” techniques to minimize the potential for contamination, as described in detail in the QAPP. Samples for dissolved metals analysis (not including mercury) were filtered in the field. Samples were stored on ice in a cooler directly after being filled.

The criteria for the storm event were as follows: the storm had to have an intensity of at least 0.25 in. of rain in a 24-hr period as recorded at the Boeing Field National Weather Service station, and sampling had to occur either during the storm event or as soon as possible after the event, but no longer than 24 hrs after the event. Rainfall data collected at the Boeing Field National Weather Service station indicated that there was a precipitation level of 2.29 in. the day the sampling event began (January 7, 2009), thus meeting the storm event criteria (NOAA 2009).



Prepared by CEH, 06/04/09, MAP #3817, W:\Projects\00-05-08 East Waterway\EW R\FSD\GISData\Report\Surface Water



^a Only sampled in Round 1, was replaced by location EW-SW-5
^b Sampled in Rounds 2 through 5, replaced sample locatoin EW-SW-4

Map 2-1
 Surface Water Sampling Locations
 Surface Water Data Report
 East Waterway Study Area

Coordinates for each surface water sample are presented in Table 2-2.

Table 2-2. Coordinates for surface water sampling locations

Sampling Location	Latitude	Longitude	Sampling Location	Latitude	Longitude
Round 1			Round 4		
EW-SW-1 ^a	47.570370	-122.345670	EW-SW-1	47.570330	-122.345779
EW-SW-2	47.576879	-122.344048	EW-SW-1-IT	47.570330	-122.345799
EW-SW-3	47.578651	-122.340931	EW-SW-2	47.577029	-122.344348
EW-SW-4	47.590120	-122.343241	EW-SW-2-IT	47.577029	-122.344348
Round 2			EW-SW-3	47.578629	-122.340950
EW-SW-1 ^a	47.570431	-122.345632	EW-SW-5	47.590349	-122.340430
EW-SW-2	47.577039	-122.344381	EW-SW-6 ^a	47.589630	-122.344649
EW-SW-3	47.578640	-122.340938	EW-SW-6-IT	47.589629	-122.344519
EW-SW-5	47.590360	-122.340451	Round 5		
EW-SW-6	47.589611	-122.344608	EW-SW-1	47.570360	-122.345780
Round 3			EW-SW-2	47.576971	-122.344371
EW-SW-1	47.570349	-122.345779	EW-SW-3	47.578639	-122.340971
EW-SW-2 ^a	47.577021	-122.344332	EW-SW-5 ^a	47.590329	-122.340511
EW-SW-3	47.578651	-122.340951	EW-SW-6	47.589650	-122.344609
EW-SW-5	47.590330	-122.340478			
EW-SW-6	47.589671	-122.344630			

^a One field replicate sample was collected at each of these locations (one per sampling round). Sample IDs are as follows: EW-SW-101-L-1 (Round 1), EW-SW-101-L-2 (Round 2), EW-SW-101-U-3 (Round 3), EW-SW-101-L-4 (Round 4), and EW-SW-101-L-5 (Round 5).

IT – incoming (or flood) tide

Water quality parameters were measured in the field using a Hydrolab Series 4a MiniSonde[®]. The Hydrolab was lowered to the targeted depth at each location and allowed to equilibrate before measurements were taken for conductivity, temperature, dissolved oxygen, and pH. These conventional water quality parameters were noted on the surface water collection forms along with the global positioning system location and depth as read by the boat's depth sounder (provided in Appendix E). Table 2-3 summarizes field measurements for each sampling round, including sampling dates and times.

Table 2-3. Field measurements for surface water samples

Sample ID	Date	Time	Tide Stage	Temperature (°C)	Dissolved Oxygen (mg/L)	pH	Conductivity (µS/cm)
Round 1							
EW-SW-1-U-1	9/11/2008	5:53	ebb	14.12	8.00	7.66	34,360
EW-SW-1-L-1		7:15		12.54	7.76	7.75	7,765
EW-SW-2-U-1	9/12/2008	8:38	ebb	13.11	8.67	7.83	38,430
EW-SW-2-L-1		9:15		12.05	5.94	7.79	39,820
EW-SW-3-U-1	9/11/2008	8:31	slack	13.52	8.19	7.74	38,110
EW-SW-3-L-1		9:00		12.17	6.17	7.66	39,410
EW-SW-4-U-1	9/12/2008	6:50	ebb	13.08	8.28	7.74	37,250
EW-SW-4-L-1		7:25		12.38	7.42	7.75	39,540
Round 2							
EW-SW-1-U-2	9/27/2008	7:03	ebb	12.76	6.54	7.67	28,380
EW-SW-1-L-2		7:47		12.29	6.53	7.74	33,620
EW-SW-2-U-2	9/26/2008	6:12	ebb	12.33	6.32	7.72	32,640
EW-SW-2-L-2		7:20		12.12	5.71	7.7	34,000
EW-SW-3-U-2	9/26/2008	8:22	slack	12.49	6.42	7.7	32,270
EW-SW-3-L-2		8:55		12.16	5.3	7.66	33,980
EW-SW-5-U-2	9/25/2008	7:05	ebb	12.63	6.28	7.68	32,960
EW-SW-5-L-2		7:43		12.16	6.41	7.75	34,021
EW-SW-6-U-2	9/25/2008	5:23	ebb	12.49	7.09	7.68	32,020
EW-SW-6-L-2		6:02		12.1	6.34	7.73	34,060
Round 3							
EW-SW-1-U-3	12/11/200	18:40	ebb	8.99	7.94	7.61	27,610
EW-SW-1-L-3		19:10		10.32	6.47	7.67	34,220
EW-SW-2-U-3	12/9/2008	19:00	ebb	9.79	7.05	7.64	34,870
EW-SW-2-L-3		20:05		10.44	6.47	7.64	34,110
EW-SW-3-U-3	12/10/2008	20:30	slack	9.62	7.37	7.63	34,870
EW-SW-3-L-3		21:00		10.47	5.95	7.47	64,080
EW-SW-5-U-3	12/9/2008	17:10	ebb	10.04	6.83	7.59	34,480
EW-SW-5-L-3		18:20		10.43	6.27	7.63	34,110
EW-SW-6-U-3	12/10/200	17:55	ebb	9.79	7.19	7.59	34,700
EW-SW-6-L-3		18:25		10.83	7.64	7.61	64,280

Sample ID	Date	Time	Tide Stage	Temperature (°C)	Dissolved Oxygen (mg/L)	pH	Conductivity (µS/cm)
Round 4							
EW-SW-1-U-4	1/9/2009	18:21	ebb	5.59	8.09	7.26	26,703
EW-SW-1-L-4		18:55		7.54	7.04	7.62	33,680
EW-SW-1-U-4-IT	1/9/2009	22:10	flood	5.08	8.25	7.37	3,685
EW-SW-1-L-4-IT		22:40		7.53	6.98	7.5	34,590
EW-SW-2-U-4	1/8/2009	19:15	ebb	7.9	7.03	7.55	22,880
EW-SW-2-L-4		20:15		8.7	6.06	7.71	38,770
EW-SW-2-U-4-IT	1/8/2009	21:35	flood	8.17	6.75	7.67	31,510
EW-SW-2-L-4-IT		21:10		8.73	6.02	7.72	38,730
EW-SW-3-U-4	1/9/2009	20:45	slack	7.44	7.04	7.54	25,170
EW-SW-3-L-4		21:21		8.69	6.01	7.64	38,800
EW-SW-5-U-3	1/8/2009	17:31	ebb	7.9	7.08	7.63	24,470
EW-SW-5-L-3		18:04		8.58	5.88	7.67	38,910
EW-SW-6-U-4	1/7/2009	16:39	ebb	7.59	7.07	7.67	26,700
EW-SW-6-L-4		17:30		8.74	5.98	7.71	38,720
EW-SW-6-U-4-IT	1/7/2009	20:10	flood	8.44	6.94	7.65	24,800
EW-SW-6-L-4-IT		20:50		8.51	6.45	7.74	38,990
Round 5							
EW-SW-1-U-5	2/23/2009	19:05	ebb	7.57	9.92	7.61	33,070
EW-SW-1-L-5		19:40		7.69	9.54	7.71	44,650
EW-SW-2-U-5	2/22/2009	18:30	ebb	7.66	9.85	7.64	38,190
EW-SW-2-L-5		19:10		7.7	8.91	7.68	45,140
EW-SW-3-U-5	2/22/2009	20:30	slack	7.89	9.57	7.71	43,250
EW-SW-3-L-5		21:10		7.8	8.49	7.61	45,100
EW-SW-5-U-5	2/21/2009	17:52	ebb	7.28	9.58	7.69	35,100
EW-SW-5-L-5		18:20		7.67	9.14	7.71	45,200
EW-SW-6-U-5	2/21/2009	19:45	ebb	7.74	9.79	7.7	41,770
EW-SW-6-L-5		20:20		7.65	9.24	7.72	45,280

C – centigrade
ID – identification

2.2 SAMPLE IDENTIFICATION SCHEME

The first two characters of the location identification (ID) are “EW” to identify the East Waterway project area. The next characters are “SW” with two consecutive numbers to identify the medium sampled (surface water) and the specific location that was sampled within the EW. The sample ID consisted of the location ID followed by an identifier for water depth: U (upper, 1 m below the water surface) or L (lower, 1 m above the bottom). The final character identified the sampling event (e.g., 1 for the first sampling event). For field replicates, “101” was used in place of the specific location number. Samples that were taken during a flood (e.g., incoming) tide were identified with “IT” after the sampling event, and rinsate blank samples were identified with “RB” after the sampling event.

Examples of sample IDs are provided below:

- ◆ EW-SW-1 (East Waterway, surface water survey, sampling location 1)
- ◆ EW-SW-1-L-1 (East Waterway, surface water survey, sampling location 1, collected from 1 m above the bottom, first sampling event)
- ◆ EW-SW-2-L-4-IT (East Waterway, surface water survey, sampling location 2, collected from 1 m above the bottom, fourth sampling event, (flood or incoming tide)
- ◆ EW-SW-101-U-3 (East Waterway, surface water survey, field replicate, collected from 1 m below the water’s surface, third sampling event)
- ◆ EW-SW-2-U-4-RB (East Waterway, surface water survey, sampling location 2, collected from 1 m below the water’s surface, forth sampling event, rinsate blank)

2.3 FIELD DEVIATIONS FROM THE QAPP

Field deviations from the QAPP (Windward 2008) included minor modifications to the collection methods. These field deviations did not affect the data quality and are discussed in detail below.

- ◆ The QAPP specified that the main channel locations would be sampled during both ebb and flood tides as part of Round 2 in September 2008 in order to characterize both tidal conditions. The main channel locations were sampled during both ebb and flood tides as part of Round 4 in January 2009 rather than Round 2.
- ◆ The QAPP specified that location EW-SW-03 in Slip 27 would be sampled at one depth (1 m above the bottom) because it was expected to be relatively shallow. Instead, location EW-SW-03 was sampled at both depths within the water column (1 m below the surface and 1 m above the bottom) to be consistent with the other sampling locations.

3 Laboratory Methods

The methods and procedures used to chemically analyze the surface water samples are described briefly in this section and in detail in the surface water QAPP (Windward 2008). The laboratories followed all of the methods and procedures described in the QAPP, with one exception. Conductivity was measured by Analytical Resources, Inc. (ARI). This analysis was not listed in the QAPP.

Surface water samples were hand-delivered to ARI and Brooks Rand or were shipped via overnight delivery to Analytical Perspectives for polychlorinated biphenyl (PCB) congener analysis. Depending on the time and day of sample collection, samples were either delivered immediately following sample collection or were transported to Windward Environmental LLC's (Windward's) office and stored refrigerated until delivery to the laboratory. All samples were analyzed for metals, including mercury (total and filtered); PCB congeners; semivolatile organic compounds (SVOCs), including polycyclic aromatic hydrocarbons (PAHs); butyltins; total suspended solids; total organic carbon (TOC); dissolved organic carbon; conductivity; salinity; and turbidity. Brooks Rand Labs LLC (Brooks Rand) conducted the metals analyses, Analytical Perspectives conducted the PCB congener analyses, and ARI conducted the remaining analyses. Chemical analysis methods are identified in Table 3-1. All methods selected represent standard methods used for the analysis of these analytes in surface water. Conductivity was also measured in the field during sample collection. The conductivity results from ARI are in the project database.

Table 3-1. Analytical methods for surface water analyses

Parameter	Method	Sample Holding Time	Preservation	Laboratory
Mercury (dissolved) ^a	CVAF (EPA 1631E)	90 days	preserved with hydrochloric acid or bromine chloride at the laboratory, cool, 0 – 6 °C	Brooks Rand
Mercury (total)	CVAF (EPA 1631E)	90 days	cool, 0 – 6 °C	Brooks Rand
Metals (dissolved) ^a	ICP-MS (EPA 1640 modified)	6 months	preserved with nitric acid to pH < 2 at laboratory, cool, 0 – 6 °C	Brooks Rand
Metals (total)	ICP-MS (EPA 1640 modified)	6 months	preserved with nitric acid to pH < 2 at laboratory, cool, 0 – 6 °C	Brooks Rand
SVOCs	GC/MS (EPA 8270D)	7 days ^b	cool, 0 – 6 °C, dark	ARI
PAHs	GC/MS-SIM (EPA 8270D-SIM)	7 days ^b	cool, 0 – 6 °C, dark	ARI
Butyltins	GC/MS-SIM (Krone)	7 days ^b	cool, 0 – 6 °C, dark	ARI
PCB congeners	HRGC/HRMS (EPA 1668A)	1 year	cool, 0 – 6 °C	Analytical Perspectives
Total organic carbon	non-dispersive infrared combustion (EPA 415.1)	28 days	preserved with sulfuric acid to pH < 2 in the field, cool, 0 – 6 °C	ARI

Parameter	Method	Sample Holding Time	Preservation	Laboratory
Dissolved organic carbon	direct combustion (EPA 415.1)	28 days	cool, 0 – 6 °C	ARI
Total suspended solids	gravimetric (EPA 160.2)	7 days	cool, 0 – 6 °C	ARI
Salinity	electrometric (SM 2520B)	28 days	cool, 0 – 6 °C	ARI
Conductivity	electrometric (EPA 120.1)	28 days	cool, 0 – 6 °C	ARI
Turbidity	nephelometric (EPA 180.1)	48 hrs	cool, 0 – 6 °C	ARI

^a Samples for dissolved mercury analyses were filtered in the laboratory. Samples for other metals analyses were filtered in the field.

^b Seven days until extraction; forty days to analysis from time of extraction.

ARI – Analytical Resources, Inc.

CVAF – cold vapor atomic fluorescence

EPA – US Environmental Protection Agency

GC/MS – gas chromatography/mass spectrometry

HRGC/HRMS – high-resolution gas chromatography/high-resolution mass spectrometry

ICP-MS – inductively coupled plasma-mass spectrometry

PAHs – polycyclic aromatic hydrocarbons

PCB – polychlorinated biphenyl

SIM – selective ion monitoring

SVOC – semivolatile organic compound

4 Results

This section summarizes the results of the chemical analyses and compares chemical concentrations in surface water to Washington State water quality criteria (WQC). Complete data tables and laboratory report forms are presented in Appendix A and Appendix D, respectively. The approach used to average laboratory replicates and the methods for calculating total concentrations of PCBs and PAHs are presented in Appendix B. The number of significant figures shown for each concentration is the same as that reported by the analytical laboratories.

Data validation results are also summarized in this section. Quality assurance (QA) review of the surface water chemistry data was conducted in accordance with the QA/quality control (QC) requirements and technical specifications of the methods and the national functional guidance for organic and inorganic data review (EPA 1995, 1999, 2004). The complete data validation reports, including any qualified results, are presented in Appendix C.

4.1 ANALYTICAL RESULTS

This section presents the analytical chemistry results for surface water. All surface water samples were analyzed for total and dissolved metals (including mercury), PCB congeners, SVOCs, butyltins, total suspended solids, salinity, TOC, and dissolved organic carbon. Table 4-1 summarizes surface water chemistry results for data from all sampling events combined. Results for conventional parameters are also presented in Table 4-1.

Table 4-1. Summary of surface water data collected during all five sampling events (Round 1 through Round 5)

Analyte	Unit	Detection Frequency ^a	Detected Results		Reporting Limit ^b Min – Max
			Minimum	Maximum	
Metals					
Antimony (dissolved)	µg/L	24/59	0.060 J	0.156 J	0.022 – 0.191
Antimony (total)	µg/L	26/59	0.065 J	0.150 J	0.025 – 0.193
Arsenic (dissolved)	µg/L	59/59	0.43	1.41	na
Arsenic (total)	µg/L	59/59	0.23	1.89	na
Cadmium (dissolved)	µg/L	55/59	0.009 J	37.8	0.088
Cadmium (total)	µg/L	56/59	0.038 J	1.45	0.088
Chromium (dissolved)	µg/L	39/59	0.10 J	1.15 J	0.70 – 2.36
Chromium (total)	µg/L	39/59	0.15 J	3.61 J	0.70 – 2.36
Cobalt (dissolved)	µg/L	1/59	0.40	0.40	0.10 – 0.25
Cobalt (total)	µg/L	8/59	0.50	2.13	0.10 – 0.35
Copper (dissolved)	µg/L	59/59	0.23	2.44	na
Copper (total)	µg/L	59/59	0.26	8.11 J	na

Analyte	Unit	Detection Frequency ^a	Detected Results		Reporting Limit ^b Min – Max
			Minimum	Maximum	
Lead (dissolved)	µg/L	7/59	0.040 J	0.229	0.150 – 6.80
Lead (total)	µg/L	39/59	0.054 J	2.39	0.150 – 6.80
Mercury (dissolved)	µg/L	15/59	0.00016	0.00146	0.00040 – 0.00054
Mercury (total)	µg/L	47/59	0.00030	0.0277	0.00040 – 0.00058
Nickel (dissolved)	µg/L	21/59	0.27 J	0.85	0.23 – 1.00
Nickel (total)	µg/L	24/59	0.25 J	3.37	0.23 – 1.00
Selenium (dissolved)	µg/L	58/59	0.06 J	0.38 J	0.20
Selenium (total)	µg/L	59/59	0.06 J	0.44 J	na
Silver (dissolved)	µg/L	1/59	0.019	0.019	0.025 – 0.036
Silver (total)	µg/L	0/59	nd	nd	0.025 – 0.052
Thallium (dissolved)	µg/L	38/59	0.004 J	0.012	0.010 – 0.020
Thallium (total)	µg/L	39/59	0.007 J	0.021	0.015 – 0.021
Vanadium (dissolved)	µg/L	59/59	0.029 J	1.68	na
Vanadium (total)	µg/L	58/59	0.029 J	9.29	0.080
Zinc (dissolved)	µg/L	39/59	0.60	7.79	2.52 – 116
Zinc (total)	µg/L	39/59	0.63 J	15.8	2.52 – 65.0
Organometals					
Monobutyltin as ion	µg/L	3/59	0.010 J	0.036	0.008 – 0.036
Dibutyltin as ion	µg/L	2/59	0.010	0.015	0.010 – 0.012
Tributyltin as ion	µg/L	1/59	0.010 J	0.010 J	0.008 – 0.010
PAHs					
1-Methylnaphthalene	µg/L	3/59	0.015	0.091	0.010
2-Chloronaphthalene	µg/L	0/59	nd	nd	1.0
2-Methylnaphthalene	µg/L	4/59	0.010	1.0 J	0.010 – 0.028
Acenaphthene	µg/L	12/59	0.010	0.20	0.010
Acenaphthylene	µg/L	0/59	nd	nd	0.010
Anthracene	µg/L	2/59	0.011 J	0.057	0.010
Benzo(a)anthracene	µg/L	1/59	0.020	0.020	0.010
Benzo(a)pyrene	µg/L	0/59	nd	nd	0.010 – 1.0
Benzo(b)fluoranthene	µg/L	0/59	nd	nd	0.010
Benzo(g,h,i)perylene	µg/L	0/59	nd	nd	0.010
Benzo(k)fluoranthene	µg/L	0/59	nd	nd	0.010
Total benzofluoranthenes	µg/L	0/59	nd	nd	0.010
Chrysene	µg/L	4/59	0.010	0.024	0.010
Dibenzo(a,h)anthracene	µg/L	0/59	nd	nd	0.010
Dibenzofuran	µg/L	1/59	0.13	0.13	0.010
Fluoranthene	µg/L	15/59	0.010	0.19	0.010 – 0.018
Fluorene	µg/L	3/59	0.015 J	0.16	0.010
Indeno(1,2,3-cd)pyrene	µg/L	0/59	nd	nd	0.010
Naphthalene	µg/L	17/59	0.011	12	0.010 – 0.042
Phenanthrene	µg/L	13/59	0.010	0.9 J	0.010 – 0.036

Analyte	Unit	Detection Frequency ^a	Detected Results		Reporting Limit ^b Min – Max
			Minimum	Maximum	
Pyrene	µg/L	15/59	0.010	0.12	0.010
Total HPAHs	µg/L	21/59	0.010	0.35	0.010 – 1.0
Total LPAHs	µg/L	28/59	0.010	13 J	0.010 – 0.033
Total cPAHs ^c	µg/L	4/59	0.0091	0.011	0.0091 – 0.50
Total PAHs	µg/L	35/59	0.010	13 J	0.010 – 1.0
Phthalates					
Bis(2-ethylhexyl)phthalate	µg/L	3/59	2.3	7.8	1.0 – 54
Butyl benzyl phthalate	µg/L	0/59	nd	nd	1.0
Diethyl phthalate	µg/L	2/59	1.4	2.2	1.0
Dimethyl phthalate	µg/L	0/59	nd	nd	1.0
Di-n-butyl phthalate	µg/L	0/59	nd	nd	1.0
Di-n-octyl phthalate	µg/L	0/59	nd	nd	1.0
Other SVOCs					
1,2,4-Trichlorobenzene	µg/L	0/59	nd	nd	1.0
1,2-Dichlorobenzene	µg/L	0/59	nd	nd	1.0
1,3-Dichlorobenzene	µg/L	0/59	nd	nd	1.0
1,4-Dichlorobenzene	µg/L	1/59	3.1	3.1	1.0
2,4,5-Trichlorophenol	µg/L	0/59	nd	nd	5.0
2,4,6-Trichlorophenol	µg/L	0/59	nd	nd	5.0
2,4-Dichlorophenol	µg/L	0/59	nd	nd	5.0
2,4-Dimethylphenol	µg/L	0/59	nd	nd	1.0
2,4-Dinitrophenol	µg/L	0/59	nd	nd	10
2,4-Dinitrotoluene	µg/L	0/59	nd	nd	5.0
2,6-Dinitrotoluene	µg/L	0/59	nd	nd	5.0
2-Chlorophenol	µg/L	0/59	nd	nd	1.0
2-Methylphenol	µg/L	0/59	nd	nd	1.0
2-Nitroaniline	µg/L	0/59	nd	nd	5.0
2-Nitrophenol	µg/L	0/59	nd	nd	5.0
3,3'-Dichlorobenzidine	µg/L	0/59	nd	nd	5.0
3-Nitroaniline	µg/L	0/59	nd	nd	5.0
4,6-Dinitro-o-cresol	µg/L	0/59	nd	nd	10
4-Bromophenyl phenyl ether	µg/L	0/59	nd	nd	1.0
4-Chloro-3-methylphenol	µg/L	0/59	nd	nd	5.0
4-Chloroaniline	µg/L	0/59	nd	nd	5.0
4-Chlorophenyl phenyl ether	µg/L	0/59	nd	nd	1.0
4-Methylphenol	µg/L	0/59	nd	nd	1.0
4-Nitroaniline	µg/L	0/59	nd	nd	5.0
4-Nitrophenol	µg/L	0/59	nd	nd	5.0
Aniline	µg/L	0/50	nd	nd	1.0
Benzoic acid	µg/L	0/59	nd	nd	10
Benzyl alcohol	µg/L	0/59	nd	nd	5.0
Bis(2-chloroethoxy)methane	µg/L	0/59	nd	nd	1.0

Analyte	Unit	Detection Frequency ^a	Detected Results		Reporting Limit ^b Min – Max
			Minimum	Maximum	
Bis(2-chloroethyl)ether	µg/L	0/59	nd	nd	1.0
Bis(2-chloroisopropyl)ether	µg/L	0/59	nd	nd	1.0
Carbazole	µg/L	0/59	nd	nd	1.0
Hexachlorobenzene	µg/L	0/59	nd	nd	1.0
Hexachlorobutadiene	µg/L	0/59	nd	nd	1.0
Hexachlorocyclopentadiene	µg/L	0/59	nd	nd	5.0
Hexachloroethane	µg/L	0/59	nd	nd	1.0
Isophorone	µg/L	0/59	nd	nd	1.0
Nitrobenzene	µg/L	0/59	nd	nd	1.0
n-Nitrosodimethylamine	µg/L	0/51	nd	nd	5.0
n-Nitroso-di-n-propylamine	µg/L	0/59	nd	nd	5.0
n-Nitrosodiphenylamine	µg/L	0/59	nd	nd	1.0
Pentachlorophenol	µg/L	0/59	nd	nd	5.0
Phenol	µg/L	0/59	nd	nd	1.0
PCBs					
Total PCB congeners	µg/L	57/57	6.77 x 10 ⁻⁵ J	5.838 x 10 ⁻³ J	na
Conventionals					
Conductivity	µmhos/cm	59/59	3,300	58,500	na
Dissolved organic carbon	mg/L	10/59	1.67	3.25	1.50
Salinity	ppt	59/59	1.70	27.7	na
TOC	mg/L	20/59	1.51	3.36	1.50
Total suspended solids	mg/L	59/59	1.1	159	na
Turbidity	NTU	59/59	0.26	140 J	na

^a Field replicates are included.

^b Reporting limits are not presented if the analyte was detected in all samples.

^c Total cPAHs were calculated by summing the products of individual cPAH concentrations and compound-specific PEFs for individual cPAH compounds, as described in detail in Appendix B. If an individual cPAH compound was not detected, the PEF for that compound was multiplied by one-half the RL for that compound.

^d

cPAH – carcinogenic polycyclic aromatic hydrocarbon

HPAH – high-molecular-weight polycyclic aromatic hydrocarbon

J – estimated concentration

LPAH – low-molecular-weight polycyclic aromatic hydrocarbon

na – not applicable

nd – not detected

NTU – nephelometric turbidity unit

PAH – polycyclic aromatic hydrocarbon

PCB – polychlorinated biphenyl

PEF – potency equivalency factor

ppt – parts per thousand

SVOC – semivolatile organic compound

TEQ – toxic equivalent

TEF – toxic equivalency factor

TOC – total organic carbon

Metals detected most frequently in surface water samples were arsenic, cadmium, copper, selenium, and vanadium (in 90% or more of the samples). Cobalt and silver were detected infrequently (in 14% or less of the samples). The remainder of the metals (antimony, chromium, lead, mercury, nickel, thallium, and zinc) were detected in 41 to 80% of the samples. Of these seven remaining metals, the detection frequency was lower in Rounds 1 and 2 (dry-weather events) than in Rounds 3, 4, or 5 (wet-weather or storm events) with the exception of lead. Individual sampling results are presented in Appendix A. A more detailed analysis of results by date and depth in the water column will be presented in the SRI report.

Butyltins were infrequently detected in surface water samples at detection frequencies ranging from 2 to 8%. Butyltins were detected in samples from Rounds 1, 2, and 3 at concentrations ranging from 0.010 to 0.036 µg/L. Butyltins were not detected in any samples collected during Rounds 4 and 5.

Total PCBs (as sum of congeners) were detected in every surface water sample at concentrations ranging from 67.7 to 5,838 pg/L. Results for individual samples and for each of the PCB congeners are presented in Appendix A. Toxic equivalents (TEQs) of PCBs were calculated by summing the products of concentrations and congener-specific toxic equivalency factors, as discussed in detail in Appendix B. PCB TEQs in surface water were less variable than total PCB concentrations, ranging from 0.447 to 0.689 pg/L. The SRI will include a more detailed analysis of PCB concentrations by date and depth in the water column.

Phthalates were rarely detected in surface water samples, and only bis(2-ethylhexyl) phthalate (BEHP) and diethyl phthalate were detected. BEHP was detected in three samples during Round 1, and diethyl phthalate was detected in two samples during Round 2. Detected concentrations ranged from 1.4 to 7.8 µg/L.

Twelve individual PAH compounds were detected in surface water. The most frequently detected PAHs were acenaphthene (20%), fluoranthene (25%), naphthalene (29%), phenanthrene (22%), and pyrene (25%). The remaining PAHs (1-methylnaphthalene, 2-methylnaphthalene, anthracene, benzo(a)anthracene, chrysene, dibenzofuran, and fluorene) were detected at frequencies ranging from 2 to 7%. Individual sampling results are presented in Appendix A. A more detailed analysis of PAH results by date and depth in the water column will be presented in the SRI.

1,4-Dichlorobenzene was the only other SVOC detected in surface water.

1,4-Dichlorobenzene was detected at a concentration of 3.1 µg/L in a sample collected during Round 4.

As part of the Washington State surface water quality standards (WAC 173-201A-240), numerical criteria are promulgated for priority toxic substances for both marine and freshwaters. These aquatic life water quality criteria (WQC) are referred to as WQC in this section. Chemical concentrations detected in EW surface water samples are compared to Washington State marine WQC in Table 4-2. Acute WQC represent short-

Table 4-2. Detected chemical concentrations in surface water compared with Washington State WQC

Analyte	Detection Frequency	Comparison of Individual Concentrations to Marine Acute WQC ^a				Comparison of Mean Concentrations to Marine Chronic WQC ^a		
		Marine Acute WQC (µg/L) ^b	Detected Concentration (µg/L)		No. of Samples Exceeding Marine Acute WQC	Marine Chronic WQC (µg/L) ^c	Mean Concentration (µg/L) ^d	Mean Concentration Exceeds Marine Chronic WQC?
			Min	Max				
Metals								
Arsenic (filtered)	59/59	69	0.43	1.41 J	0	36	1.0	no
Cadmium (filtered)	55/59	42	0.009 J	37.8 ^e	0	9.3	0.70	no
Chromium (filtered)	39/59	1,100	0.10 J	1.15 J	0	50	0.38	no
Copper (filtered)	59/59	4.8	0.23	2.44	0	3.1	0.74	no
Lead (filtered)	7/59	210	0.040 J	0.229	0	8.1	0.59 ^f	no
Mercury (unfiltered)	47/59	1.8	0.00030	0.0277	0	0.025	0.0031	no
Nickel (filtered)	21/59	74	0.27 J	0.85	0	8.2	0.32	no
Selenium (filtered)	58/59	290	0.06 J	0.38 J	0	71	0.20	no
Silver (filtered)	1/59	1.9	0.019	0.019	0	nc	0.015 ^f	nc
Zinc (filtered)	39/59	90	0.60	7.79	0	81	4.3	no
PCBs								
Total PCBs (as congener sum; unfiltered)	57/57	10	6.77 x 10 ⁻⁵ J	5.838 x 10 ⁻³ J	0	0.03	1.31 x 10 ⁻³	no

^a WQC are based on dissolved concentrations for metals (except mercury) and total concentrations for mercury and organic compounds. Comparisons were conducted using dissolved concentrations (filtered samples) for metals, except for the mercury comparison, which was conducted using total concentrations (unfiltered samples). Comparisons for PCBs were conducted using total concentrations (unfiltered samples).

^b Acute criteria are 1-hr average concentrations not to be exceeded more than once every 3 yrs on average, with the exception of the silver concentration, which is an instantaneous concentration not to be exceeded at any time, or the PCB concentration, which is a 24-hr average not to be exceeded at any time.

^c Chronic criteria are 4-day average concentrations not to be exceeded more than once every 3 yrs on average, with the exception of the PCB concentration, which is a 24-hr average concentration not to be exceeded at any time.

^d Mean concentration is the mean of detected concentrations and one-half the RL for non-detected results.

- ^e Dissolved concentration for this sample is considerably higher than the total concentration (1.45 µg/L) which results in considerable uncertainty associated with this result.
- ^f Calculated mean concentrations were outside the range of detected concentrations for lead and silver because the method for calculating the mean uses one-half the RL for non-detected results.

AWQC – ambient water quality criteria

J – estimated concentration

nc – no criteria

PCB – polychlorinated biphenyl

RL – reporting limit

WQC – water quality criteria

term exposure concentrations (generally 1-hr average concentrations), so individual surface water concentrations were compared to acute WQC. Chronic WQC represent longer-term exposure concentrations (generally, 4-day average concentrations). Therefore, average concentrations over the five sampling rounds were compared to chronic WQC to represent these longer-term exposure concentrations. Mean concentrations were calculated using one-half the RL for non-detected results. There were no exceedances of an acute WQC. None of the mean concentrations exceeded the chronic WQC.

4.2 COMPARISON OF NON-DETECTED RESULTS WITH ANALYTICAL CONCENTRATION GOALS

This section compares reporting limits (RLs) and method detection limits (MDLs) for non-detected concentrations in surface water samples to site-specific analytical concentration goals (ACGs) that were presented in Appendix D of the QAPP (Windward 2008). The target detection limits for the analyses were also identified in the QAPP appendix and are presented in this section. Actual MDLs and RLs may differ from the target detection limits as a result of QC issues encountered during sample analysis.

For analyses conducted at ARI and AP, the sample-specific RLs are based on the lowest point of the calibration curve associated with each analysis, whereas the RLs reported by Brooks Rand are calculated as three times the MDL. The MDLs reported by ARI and Brooks Rand are statistically derived following EPA methods (40 CFR 136). The MDLs reported by AP are sample specific estimated detection limits that are calculated as four times the signal to noise ratio of each sample. In some specific cases where method blank contamination was found, Brooks Rand elevated their reported MDLs and RLs to a level higher than the laboratory contamination. Detected concentrations between the MDL and RL were reported by the laboratories and are flagged with a J-qualifier to indicate that the reported concentration is an estimate.

All RLs and MDLs for surface water samples were lower than the risk-based ecological ACGs developed for fish for all analytes, with the exception of one result for zinc at a concentration of 116 µg/L, which is greater than the fish ACG of 81 µg/L, which is based on the marine chronic WQC. The analytical sensitivity (i.e., MDL) for this analysis was well below the WQC; however, this RL is elevated because of because of spot contamination found in some method blank samples at the laboratory during the time of sample preparation and analysis.

All RLs and MDLs for surface water samples were lower than the risk-based ACGs developed for human health, with the exception of the non-detected results for the chemicals listed in Table 4-3. Most of these chemicals were identified in Appendix D of the QAPP (Windward 2008) as having target RLs and MDLs above the ACGs for human health, with the exception of zinc, benzo(a)pyrene, and BEHP. The RLs for

Table 4-3. Number of RLs and MDLs above the human health ACGs in surface water samples

Analyte	Unit	No. of Detected Results	Range of Detected Results	No. of Non-Detected Results	Range of RLs for Non-Detected Results	No. of RLs > ACG	Range of MDLs for Non-Detected Results	No. of MDLs > ACG	Target MDL	Human Health ACG
Metals										
Zinc (dissolved)	µg/L	39	0.6 – 7.79	20	2.52 – 116	11 ^a	0.84 – 6.6	0	0.08	11
Zinc (total)	µg/L	39	0.63 – 15.8	20	2.52 – 65	12 ^a	0.84 – 6.6	0	0.08	11
PAHs										
Benzo(a)pyrene	µg/L	0	nd	59	0.010 – 1.0	4	0.003 – 0.2	4	0.0031	0.029
Phthalates										
BEHP	µg/L	3	2.3 – 7.8	56	1.0 – 54	1 ^a	0.2 – 0.7	0	0.53	48
Other SVOCs										
3,3'-Dichlorobenzidine	µg/L	0	nd	59	5.0	59	1.0 – 1.8	11	1.1	1.5
bis(2-chloroethyl)ether	µg/L	0	nd	59	1.0	59	0.2 – 0.6	59	0.31	0.098
Hexachlorobenzene	µg/L	0	nd	59	1.0	59	0.2 – 0.9	11	0.24	0.42
n-Nitrosodimethylamine	µg/L	0	nd	51	5.0	51	0.3 – 1.6	51	0.71	0.0042
n-Nitroso-di-n-propylamine	µg/L	0	nd	59	5.0	59	0.8 – 2.8	59	1.1	0.1

^a The ACG was exceeded because the RLs were elevated based on laboratory method blank contamination at the time of sample preparation and analysis.

ACG – analytical concentration goal

BEHP – bis(2-ethylhexyl) phthalate

MDL – method detection limit

PAH – polycyclic aromatic hydrocarbon

RL – reporting limit

SVOC – semi-volatile organic compound

these chemicals were elevated because of laboratory contamination (zinc and BEHP) or because of QC issues with the specified analysis. The zinc and BEHP analyses were sufficiently sensitive to meet the ACGs, however, the RLs were elevated because of laboratory contamination at the time of analysis. For benzo(a)pyrene, four of the 59 non-detected results exceeded the ACG. More details on QC issues are presented in the following section on data validation.

4.3 DATA VALIDATION RESULTS

The analyses of the surface water samples were conducted using the sample delivery group (SDG) assignments designated by the laboratories, which are listed in Table 4-4.

Table 4-4. SDGs for surface water samples

SDG	Laboratory	Round	No. of Samples	Analyses
NO50	ARI	1	5	SVOCs, pesticides, butyltins, conventionals
NO81	ARI	1	4	SVOCs, pesticides, butyltins, conventionals
P9708	Analytical Perspectives	1	5	PCB congeners
P9714	Analytical Perspectives	1	4	PCB congeners
0837043	Brooks Rand	1, 2	20	metals including mercury
NR24	ARI	2	4	SVOCs, pesticides, butyltins, conventionals
NQ90	ARI	2	4	SVOCs, pesticides, butyltins, conventionals
NR46	ARI	2	3	SVOCs, pesticides, butyltins, conventionals
P9762	Analytical Perspectives	2	4	PCB congeners
P9768	Analytical Perspectives	2	6	PCB congeners
OO41	ARI	3	5	SVOCs, pesticides, butyltins, conventionals
OD80	ARI	3	4	SVOCs, pesticides, butyltins, conventionals
OD83	ARI	3	2	SVOCs, pesticides, butyltins, conventionals
P9952	Analytical Perspectives	3	5	PCB congeners
P9953	Analytical Perspectives	3	4	PCB congeners
P9959	Analytical Perspectives	3	2	PCB congeners
0850026	Brooks Rand	3	11	metals including mercury
OG99	ARI	4	5	SVOCs, pesticides, butyltins, conventionals
OH54	ARI	4	6	SVOCs, pesticides, butyltins, conventionals

SDG	Laboratory	Round	No. of Samples	Analyses
OH20	ARI	4	6	SVOCs, pesticides, butyltins, conventionals
P1040	Analytical Perspectives	4	4	PCB congeners
P1042	Analytical Perspectives	4	6	PCB congeners
P1047	Analytical Perspectives	4	6	PCB congeners
0902030	Brooks Rand	4	17	metals including mercury
OO02	ARI	5	2	SVOCs, pesticides, butyltins, conventionals
ON72	ARI	5	9	SVOCs, pesticides, butyltins, conventionals
P1142	Analytical Perspectives	5	9	PCB congeners
P1146	Analytical Perspectives	5	2	PCB congeners
0909001	Brooks Rand	5	11	metals including mercury

ARI – Analytical Resources, Inc.

PCB – polychlorinated biphenyl

SDG – sample delivery group

SVOC – semivolatile organic compound

Independent full-level data validation was performed by EcoChem on all results in accordance with the QA/QC requirements and technical specifications of the methods and the national functional guidance for organic and inorganic data review (EPA 1995, 1999, 2004). The data validation involved a review of all QC summary forms, including initial calibration, continuing calibration verification (CCV), internal standard, surrogate, laboratory control sample (LCS), laboratory control sample duplicate (LCSD), matrix spike (MS), matrix spike duplicate (MSD), and interference check sample summary forms. The majority of the data did not require qualification or were qualified with a J, indicating that the concentration was an estimated value. Seventeen results for two chemicals were rejected as a consequence of data validation. Rejected results will not be used for any purpose. Based on the information reviewed, the overall data quality was considered acceptable for all uses, as qualified. Information regarding every qualified sample is presented in Appendix C.

Metals

- ◆ Results for various metals were qualified as estimated (J- or UJ-qualified) because recoveries or relative percent differences for MS/MSD, LCS/LCSD, CCV, or laboratory duplicate samples were outside of control limits. Metals results qualified as estimated include the following: 78 results for antimony; 67 results for nickel; 36 results for cadmium; 34 results each for chromium, selenium, silver and zinc; 20 results for arsenic; 19 results for vanadium; 16 results for copper; and 1 result for cobalt. When MS/MSD results for metals are outside of QC criteria, all associated sample results within the preparatory batch are qualified as estimated.

- ◆ Results for the following metals were re-qualified as non-detect (U qualified) because of method blank contamination: silver (118 results, ranging from 0.013 to 0.052 µg/L), cobalt (106 results, ranging from 0.07 to 0.35 µg/L), nickel (76 results, ranging from 0.23 to 0.60 µg/L), antimony (69 results, ranging from 0.022 to 0.193 µg/L), thallium (40 results, ranging from 0.015 to 0.021 µg/L), zinc (26 results, ranging from 1.37 to 116 µg/L), chromium (21 results, ranging from 0.43 to 1.30 µg/L), monobutyltin ion (14 results, ranging from 0.008 to 0.036 µg/L), and mercury (11 results, ranging from 0.20 to 0.58 µg/L).
- ◆ After data qualification for method blank contamination, the remaining detected results in the field blanks (i.e., rinsate blanks and ambient blanks) were used to evaluate potential field contamination in the samples. Detected results less than five times the associated field blank concentration were U-qualified as not detected. Nineteen results for the following chemicals were requalified as non-detect because of rinsate blank contamination: cadmium (8 results, ranging from 0.068 to 0.086 µg/L), lead (7 results, ranging from 0.039 to 0.105 µg/L), and monobutyltin (4 results, ranging from 0.01 to 0.02 µg/L).
- ◆ Forty results for TBT were qualified as estimated (J- or UJ-qualified) because recoveries for MS/MSD, or LCS/LCSD were outside of control limits.

SVOCs

- ◆ Nine results for aniline and eight results for n-nitrosodimethylamine were rejected because the instrument conditions were not suitable for the analysis of these specific chemicals because of laboratory error.
- ◆ Sixteen results for specific other SVOCs in sample EW-SW-2-L-4-IT were qualified as estimated (J- or UJ-qualified) because this sample was re-extracted and re-analyzed outside of the 7-day QAPP-specified holding time. The initial analysis was performed within holding time but was not selected as the final, best result for these chemicals because of low surrogate recoveries in the initial analysis.
- ◆ Results for the following SVOCs were re-qualified as non-detect (U qualified) because of method blank contamination: naphthalene (23 results, ranging from 0.010 to 0.042 µg/L), phenanthrene (12 results, ranging from 0.013 to 0.046 µg/L), fluoranthene (9 results, ranging from 0.012 to 0.018 µg/L), 2-methylnaphthalene (4 results, ranging from 0.011 to 0.028 µg/L), and bis(2-ethylhexyl) phthalate (4 results, ranging from 1.0 to 54 µg/L)
- ◆ Results for various chemicals were qualified as estimated (J- or UJ-qualified) because recoveries for MS/MSD, LCS/LCSD, CCV, or surrogate compounds were outside of control limits. Results qualified as estimated include the following: 123 results for 43 specific SVOCs, 81 results for 20 PAHs, and 13 results for 6 phthalates. When MS/MSD results are outside of QC criteria, only the associated sample result is qualified as estimated.

PCBs

- ◆ Results for 245 specific PCB congeners were qualified as estimated (J- or UJ-qualified) because surrogate spike recoveries (e.g., labeled compounds and recovery standards) were outside of control limits.
- ◆ Results for PCB congeners were re-qualified as non-detect (U qualified) because of method blank contamination for 202 results with concentrations ranging from 0.856 to 67.2 pg/L.

Conventionals

- ◆ Six results for turbidity were J-qualified as estimated because the samples were analyzed 2 days beyond the QAPP-specified holding time of 48 hrs. These samples were collected during a weekend and were delivered to ARI on the next business day. These samples were then analyzed the following business day for turbidity.

5 References

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